Remarks

Claims 1, 4-8, 11-13, 15-18, 21-23, 25-27, 29, 32, 35 and 37-39 are currently pending in the subject application and are presently under consideration. Claims 1, 4, 8, 11, 15 and 21 have been amended as shown on pp. 2-6 of the Reply.

Favorable reconsideration of the subject patent application is respectfully requested in view of the comments and amendments herein.

I. Rejection of Claims 1, 4-8, 11-13, 15-17, 25-27, 29, 32, 37 and 38 Under 35 U.S.C. §112, second paragraph

In the Final Office Action dated April 1, 2010, claims 1, 4-8, 11-13, 15-17, 25-27, 29, 32, 37 and 38 stand rejected under 35 U.S.C. §112, second paragraph as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. The Examiner states that the omitted steps are: the "thermal barrier ceramic coating application" step, which should be positively recited in claims 1 and 8. Claims 1, 4-8, 11-13, 15-17, 25-27, 29, 32, 37 and 38 have been amended to correct any deficiencies related to this rejection, as such the rejection is moot and should be withdrawn.

II. Rejection of Claims 4, 5, 11-13, 15 and 21-23 Under 35 U.S.C. §112, second paragraph

In the Final Office Action dated April 1, 2010, claims 4, 5, 11-13, 15 and 21-23 stand rejected under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 4, 5, 11-13, 15 and 21-23 are indefinite in that they depend from canceled claims. Accordingly, claims 4, 5, 11-13, 15 and 21-23 have been amended to correct any deficiencies related to this rejection, as such the rejection is moot and should be withdrawn.

III. Rejection of Claims 1, 6-8, 16-18, 25-27, 29, 32, 35 and 37-39 Under 35 U.S.C. §103(a)

In the Final Office Action dated April 1, 2010, claims 1, 6-8, 16-18, 25-27, 29, 32, 35 and 37-39 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Farmer *et al.* (US 6,663,919) in view of Sangeeta *et al.* (US 5,976,265). It is respectfully requested that this rejection should be withdrawn for at least the following reasons. Farmer *et al.* and Sangeeta *et al.*, individually or in combination, do not teach or suggest each and every element as set forth in the subject claims.

The subject invention relates to a process which uses an air jet containing non-abrasive particulate media at a low pressure which selectively removes thermal barrier ceramic coatings from components without damaging the metallic substrate or the desired remaining thermal barrier ceramic coating system. Specifically, the method removes a thermal barrier ceramic coating from the cooling holes of a gas turbine engine component, such as a combustion chamber. Furthermore, independent claim 1 recites a process for removing a thermal barrier ceramic coating from a cooling hole of a component comprising: ***drilling cooling holes into the component after a bond coat application and prior to a thermal barrier ceramic coating application; coating the component containing the cooling holes with the thermal barrier ceramic coating; directing an air jet at a side of the component, opposing a surface having the thermal barrier ceramic coating****, the jet containing a non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is insufficient for the media to damage a substrate but said low pressure is sufficient for the media to remove the thermal barrier ceramic coating from the cooling hole; and wherein a bond coating is interposed between the thermal barrier ceramic coating and the substrate; and* ***wherein the pressure of the air jet is from about 20 to 100 PSIG.*** The cited references do not disclose or suggest such aspects of the claimed invention.

Farmer *et al.* discloses coating a component surface containing cooling holes such that the coating deposits are introduced into the cooling holes. The component surface is coated with a metallic and/or ceramic coating material at a thickness that prevents the coating deposits from entirely filling the hole. The unfilled portion of the cooling holes provides a witness hole to guide the removal of the coating deposits. A high-pressure, liquid-containing jet is directed at the cooling holes from the surface of the component opposite the coated surface to remove the coating deposits in the cooling holes. Further, the high-pressure, liquid-containing jet contains a

non-abrasive media in a carrier fluid to remove the coating material from the cooling holes. (*See* col. 3, lines 26-44).

Additionally, the removal process of Farmer *et al.* discloses the pressure of the jet to be between 400 bar and 1100 bar. 400 bar – 1100 bar is equivalent to about 6,000 psi – about 15,000 psi (pounds per square inch). Ceramic layer bond strength is < 1,500 psi (0.016 inch thickness) and as low as 900 psi for thick ceramic layers (0.020 inch thickness). Thus, those skilled in the art of advanced thermal barrier coating processing would realize that even using fluids or other non-abrasive media in the carrier fluid plume at 400-1100 bar would cause unacceptable damage to the thermal barrier coating system as well as damage to the component's small diameter cooling holes which would adversely affect gas turbine engine performance, operability and durability. Accordingly, Farmer *et al.* would not be suitable for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required geometrical, dimensional and airflow characteristics.

Specifically, the high pressure water jet process adversely affects component cooling hole/passage geometry which, in turn has a very negative effect on component cooling, gas turbine engine performance and component durability. Furthermore, it would be obvious to those skilled in the art of thermal barrier ceramic coatings that high pressure water jet blasting would also be detrimental to the bond coat and ceramic coating layer since the high velocity and/or high pressure would certainly result in ceramic coating layer delamination (due to the fact that the high pressure fluid at 6,000 to 15,000 psi in the cooling hole would easily lift the ceramic layer with a maximum bond strength of 1,500 psi from the metallic surfaces since the ceramic layer is already under compression and the water jet pressure greatly exceeds the bonding strength of the attached ceramic layer) and loss at the cooling hole exit area(s) or, at the minimum, create delamination initiation sites which would then experience coating loss during gas turbine engine operation. In contrast, Applicants' claimed subject matter utilizes a low pressure air only process whereby all cooling hole/passage geometry and desired design characteristics are maintained or improved. Furthermore, thermal barrier ceramic coating integrity/durability is maintained and not compromised in any manner due to the low pressure process methodology.

Furthermore, Farmer *et al.* manufactures cooling holes in a component and then coats the component surface with a metallic and/or ceramic coating material and a bond coat. Thus,

the cooling holes of Farmer *et al.* are manufactured *before* any of the coating material is applied, causing the cooling holes to become deposited with all of the coating material. Thus, Farmer *et al.* requires the high pressure system due to the fact that Farmer *et al.* must remove metallic bond coat as well as ceramic deposits from the cooling holes. Applicants' claimed subject matter discloses applying a metallic bond coating to a substrate and then manufacturing air cooling holes in the component. A ceramic coating is then applied, which partially blocks the air cooling holes. An air jet is directed to the metallic surface side (*i.e.*, non-coated side) of the component opposing the thermal barrier ceramic coated surface and directed at the air cooling holes to remove only the ceramic thermal barrier deposits. (*See* Applicants' specification, pp. 10-11). As such, the air jet merely removes the ceramic thermal barrier deposits within the cooling holes and does not disturb or damage the air cooling holes, bond coat, metallic substrate or the remaining desired thermal barrier ceramic coating.

Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 1, Sangeeta *et al.* discloses a method of removing an aluminide-containing coating from the surface of a metal-based substrate. (*See* col. 2, lines 23-28). Specifically, the substrate is immersed in a bath of the stripping composition and agitated. The stripping composition degrades the surface of the coating. (*See* col. 5, lines 5-60). The Examiner relies on Sangeeta *et al.* to disclose the use of an air jet in removing an aluminide-containing material from a metallic substrate surface. (*See* Final Office Action dated 4-1-10, pg. 4). It is well known to those skilled in the art of advanced coatings that an aluminide coating is typically a metallic elemental aluminum coating which is applied (brush, spray or vapor deposition) and diffused (high temperature heat treatment) into the surface of a component while a thermal barrier ceramic coating is a ceramic material heated to achieve a plasma state and then deposited on to the component surface in layers (typically via air plasma spraying).

Accordingly, the aluminide coating as referenced in Sangeeta *et al.* would be located beneath the metallic bond coat layer which is located beneath the top coat ceramic layer. The process of Sangeeta *et al.* would have to remove and destroy the top ceramic coat layer and the metallic bond coat layer before chemical/abrasive removal of the aluminide layer could occur. The removal of the aluminide layer is the inventive purpose of Sangeeta *et al.* Thus, the process of Sangeeta *et al.* would degrade and destroy a thermal barrier coating system in order to chemically degrade and remove an underlying aluminide layer which is typically diffused into the substrate itself. Furthermore, abrasive blasting as suggested in Sangeeta *et al.* would have to be abrasive in nature, as stated in the claims since the remaining aluminide coating would

reside beneath the metallic substrate surface. Applicants' claimed subject matter discloses a substrate and a bond coating that is applied to the gas turbine engine component. Air cooling holes are then manufactured in the component and a ceramic thermal barrier coating is applied, which partially blocks the air cooling holes. As stated *supra*, an air jet is directed to the non-coated side and directed at the air cooling holes to remove the ceramic thermal barrier deposits.

Furthermore, independent claim 8 recites a process for removing a thermal barrier ceramic coating selectively from a cooling hole of a metallic turbine engine component consisting essentially of: ***drilling cooling holes into the turbine component after a bond coat application and prior to a thermal barrier ceramic coating application; coating the component containing the cooling holes with the thermal barrier ceramic coating; directing an air jet at the cooling hole of the component, wherein the air jet is directed to a side, opposing a surface having the thermal barrier ceramic coating****, the jet containing non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is sufficient to selectively remove said thermal barrier ceramic coating yet insufficient for the media to damage an underlying metallic substrate of the cooling hole; and wherein a bond coating is interposed between the thermal barrier ceramic coating and the metallic substrate; and* ***wherein the pressure of the air jet is from about 20 to 100 PSIG***. The cited references do not disclose or suggest such aspects of the claimed invention.

As stated *supra*, Farmer *et al.* discloses the use of a very high pressure fluid system. Bond coat is applied and then removed from the cooling holes using a high pressure fluid system. Thermal barrier coating is then applied and removed from the cooling holes using the same high pressure fluid system. In contrast, applicant's claimed subject matter discloses a very low pressure dry system, wherein the pressure of the air jet is from about 20 to 100 psig. The system of Farmer *et al.* would cause unacceptable damage to the thermal barrier coating system as well as damage to the component small diameter cooling holes which would adversely affect gas turbine engine performance, operability and durability. Farmer *et al.* would not be suitable for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required dimensional and airflow characteristics as well as thermal barrier ceramic coating integrity and/or durability resulting in coating loss and failure.

Furthermore, Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 8, Sangeeta *et al.* discloses degrading and removing an aluminide-containing coating,

not a thermal barrier ceramic coating. Specifically, the substrate is immersed in a bath of the stripping composition and agitated. The stripping composition degrades the surface of the coating. Accordingly, the aluminide coating as referenced in Sangeeta *et al.* would be located beneath the metallic bond coat layer which is located beneath the top coat ceramic layer. The process of Sangeeta *et al.* would have to remove and destroy the top ceramic coat layer and the metallic bond coat layer before chemical/abrasive removal of the aluminide layer could occur. The removal of the aluminide layer is the inventive purpose of Sangeeta *et al.* Thus, the process of Sangeeta *et al.* would degrade and destroy a thermal barrier coating system in order to chemically degrade and remove an underlying aluminide layer which is typically diffused into the substrate itself.

Further, independent claim 18 recites a process for forming cooling holes on a thermal barrier ceramic coated turbine engine component comprising: *drilling cooling holes into the component_after a bond coating application; coating the component containing the cooling holes with a thermal barrier ceramic coating; and* ***directing an air jet at the cooling hole of the component, wherein the air jet is directed to a side, opposing a surface having the thermal barrier ceramic coating****, the jet containing non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is sufficient to selectively remove said thermal barrier ceramic coating yet insufficient for the media to damage an underlying metallic substrate of the cooling hole; and wherein the bond coating is interposed between the thermal barrier ceramic coating and the metallic substrate; and* ***wherein the pressure of the air jet is from about 20 to 100 PSIG****.*

As stated *supra*, Farmer *et al.* discloses the use of a very high pressure fluid system. In contrast, applicant's claimed subject matter discloses a very low pressure dry system. The system of Farmer *et al.* would cause unacceptable damage to the thermal barrier coating system as well as damage to the component small diameter cooling holes which would adversely affect gas turbine engine performance operability and durability. Farmer *et al.* would not be suitable for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required dimensional and airflow characteristics as well as thermal barrier ceramic coating integrity and/or durability resulting in coating loss and failure.

Furthermore, Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 18, Sangeeta *et al.* discloses degrading and removing an aluminide-containing coating,

not a thermal barrier ceramic coating. Accordingly, the aluminide coating as referenced in Sangeeta *et al.* would be located beneath the metallic bond coat layer which is located beneath the top coat ceramic layer. The process of Sangeeta *et al.* would have to remove and destroy the top ceramic coat layer and the metallic bond coat layer before chemical/abrasive removal of the aluminide layer could occur. The removal of the aluminide layer is the inventive purpose of Sangeeta *et al.*

In view of at least the above, it is readily apparent that the cited references fail to expressly or inherently disclose applicants' claimed subject matter as recited in claims 1, 6-8, 16-18, 25-27, 29, 32, 35 and 37-39. Accordingly, it is respectfully requested that these claims be deemed allowable.

Conclusion

The present application is believed to be in condition for allowance in view of the above comments and amendments. A prompt action to such end is earnestly solicited.

In the event any fees are due in connection with this document, the Commissioner is authorized to charge those fees to Deposit Account No. 50-0983.

Should the Examiner believe a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact applicants' undersigned representative at the telephone number below.

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Respectfully Submitted,
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